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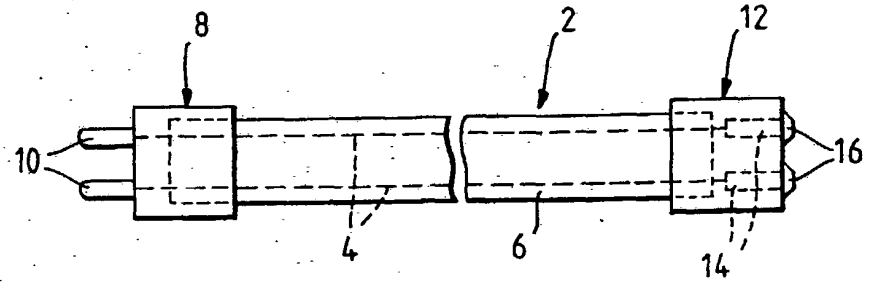
(54) Electric cable

(57) An electric cable (2), especially a self-regulating heater cable, is terminated at each end with a respective plug member (8) and a socket member (12). The plug and socket members (8, 12) are sealed to the cable (2) such that two or more lengths of cable (2) can be connected together in the field by relatively unskilled personnel.

Fig. 1.



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The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy.

Fig. 1.

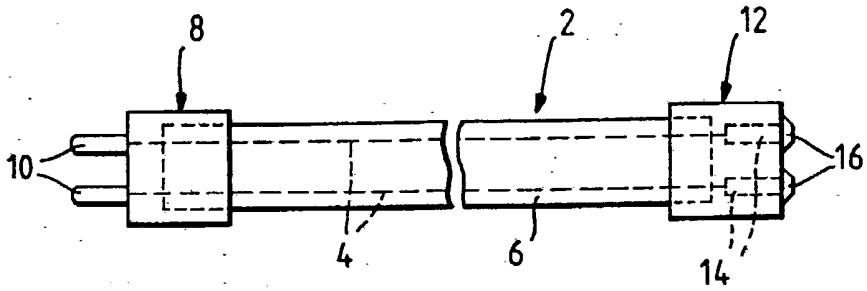


Fig. 2.

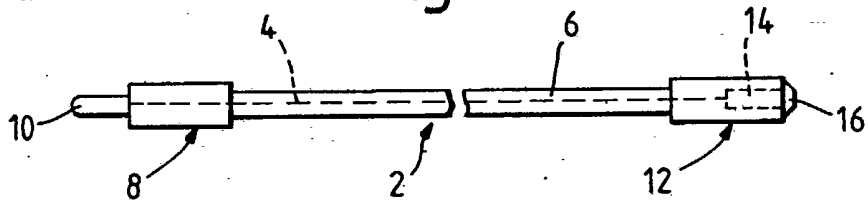


Fig. 3.

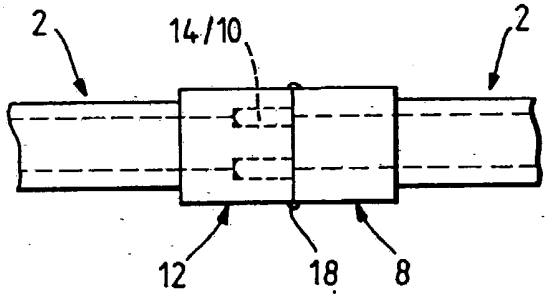


Fig. 4.

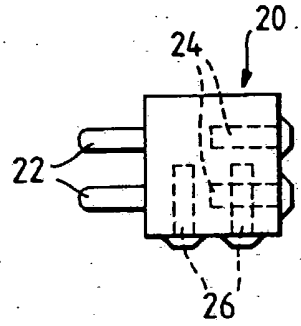
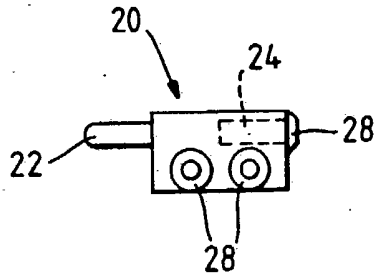


Fig. 5.



Electric Cable Interconnection

Description

This invention relates to the interconnection of electric cables, and provides a cable that is conveniently and safely interconnectable with a corresponding cable, and a method of interconnecting two cables.

An electric cable, such as a power cable, is often advantageously of indefinite length so that it may be cut to length when and where it is required. However, at other times it is advantageous that such a cable be supplied in a predetermined length and will thus be terminated at both ends, for example with a plug member at one end for the supply of electric power, and a socket member at the other end for receiving a further plug member. Electric cables containing a conductive polymeric material are usually supplied in indefinite lengths with no termination, and connectors, junction boxes and end seals are supplied as separate components. Examples of self-regulating heater cables, conductive polymeric materials, and sensing cables are disclosed in US Patents 3218384, 3296364, 3861029, 4072848, 4117312, 4185621, 4,271350, 4309597, and in EP-A-0133748, the entire disclosures of which are included herein by this reference. A termination is provided for the TRACETEK sensor cable available from RAYCHEM. The termination is in two separate parts, a first part that is sealed on to the cable and exposes sockets that are connected to respective ones of the bus conductors thereof, and a second part comprising an end cap that is threaded on to the first part that interconnects the bus conductors and thus allows the cable to function. In order to extend the length of the sensor cable, the end cap is unscrewed and a plug member on the end of an extension cable is engaged with the exposed sockets.

Extension of the length of these cables is carried out at the installation location, and may require the presence of an electrically skilled person in order to comply with regulations, and can be a time consuming operation. Furthermore, for cables of any construction, the termination or splicing thereof at the installation location can be difficult depending on the environment, and on the amount and accessibility of the working space.

It is one object of the present invention to provide an electric cable, such as a power cable, a heater cable, a sensor cable or a data transmission cable, and particularly though not exclusively a cable having one or more conductors embedded in conductive polymeric material, that allows extended lengths to be achieved in a convenient and safe manner.

In accordance with one aspect of the present invention, there is provided an electric cable comprising: at least one elongate conductor enclosed within electrically insulating material; a plug member comprising an insulating body environmentally sealed on to one end of the cable and having at least one conductive terminal electrically connected to the conductor, or to respective ones of the conductors, and projecting from the insulating body; and a one-piece socket member environmentally sealed on to the other end of the cable and having at least one conductive socket, the or each socket being arranged on removal of part of the socket member to receive therein the terminal, or respective ones of the terminals, of a plug member corresponding to said plug member.

In accordance with a further aspect of the present invention, there is provided a method of interconnecting two electric cables, each of which comprises at least one elongate conductor enclosed within electrically insulating

material, wherein a first of the cables has a plug member comprising an insulating body environmentally sealed on to one end thereof, the plug member having at least one conductive terminal electrically connected to the conductor, or to respective ones of the conductors, and projecting from the insulating body, wherein a second of the cables has a socket member sealed on to one end thereof, the socket member having at least one conductive socket that is environmentally sealed, and wherein the environmental sealing of the socket is disturbed and the plug member is engaged with the socket member so that the or each terminal engages with the or a respective socket to effect interconnection of the conductors of the two cables.

In accordance with a still further aspect of the present invention, there is provided a splice member suitable for use in connecting together two or more, and preferably three cables each of which is in accordance with said one aspect of the invention, the splice member comprising an insulating body member, at least one conductive terminal projecting therefrom, and at least one, and preferably two, sockets electrically connected with the terminal or with respective ones of the terminals, each of the sockets being environmentally sealed.

The invention thus provides a cable having an end that is sealed by an integral member, but which can conveniently be accessed to allow extension of a standard length of cable by a further standard length of cable.

The cables interconnected in this manner to form a system need not all be of the same length, nor need they be of the same type. For example, a relatively short length of power supply cable may be connected in accordance with the invention to a relatively long length of heater or sensor cable, or two lengths of heater or sensor cable may be

interconnected by a simple power cable that extends over a region where heating or sensing is not required. Thus, it will be appreciated that such standard cables and splice members in accordance with the invention may conveniently be assembled on site to produce a system to particular requirements.

Furthermore, due to the simplicity of the end fittings sealed on to the cables, a low profile is easily attainable, in contrast with the bulky junction boxes that usually have to be used.

At least some of the terminal(s) and the sockets associated therewith may extend orthogonally to each other, so that the cables thus interconnected form a T-splice.

The sealing of the sockets of the splice member is advantageously effected in the same manner as the sealing of the socket members of the cables.

The splice member may itself be sealed on to one end of the cable in place of the plug member or the socket member.

The invention thus allows a predetermined length of cable to be supplied, the cable being provided with a plug member at one end and a sealed socket member at the other end. Two or more such cables may be joined together end-to-end by interengagement of corresponding plug members and socket members simply by mechanically breaking the seal of the socket members, which seal may be arranged to seal the interconnection subsequently formed. Furthermore, the interconnection does not need to be carried out by a skilled electrician, and so cables can be installed by other persons who are available at the required time. For example, in the construction of a building, carpenters, plumbers and electricians are present on site at different times, and by

means of the present invention, electric cables can be installed at the desired stage of construction even in the absence of an electrician.

The environmental sealing will be such as to prevent access of dust, water and moisture from the environment to the insulated cable conductor.

The seal of the socket member may be effected by an insulated cap that is sealed on to the cable. The end cap may be cut off in its entirety or only partially, or broken into, so as to expose the socket(s) for receipt of the terminal(s). The seal may be provided by a sealant material, such as a gel, disposed within the socket(s), and/or within the end cap. The term gel is used herein to refer to a swollen cross-linked polymeric material, for example, a matrix of cross-linked rubber containing oil. When a sealant material is used, penetration by the terminal(s) may not destroy the seal, and advantageously is sufficient so as not to require any additonal sealing of the interconnected plug and socket members. Alternatively, the mechanical interconnection of the plug and socket members may be arranged to provide sealing without the need for additional sealant material.

The socket member may comprise two or more sockets in electrical connection with the or each conductor of the cable so that two or more plug members of respective cables may be engaged with a single socket member, to provide a T-splice for example.

Advantageously, the plug and socket members may be arranged physically so that they interengage in only one orientation, which is such as to ensure correct electrical interconnection between the cables.

In some applications, it is necessary for an interconnection between two cables in accordance with the invention

to be substantially unbreakable, that is to say when the interconnection has been made by manually pushing the plug member into the socket member, the members should not be able to be pulled apart manually using reasonable force without mechanically destroying the interconnection. To this end, the plug member and the socket member may be arranged to interlock mechanically in any suitable manner. For example, the insulating body of the socket member may contain a flexible, advantageously annular, member, and the insulating body of the plug member may have a co-operating, advantageously annular, groove therein to allow a snap fit. In another embodiment, the snap fit connection may be achieved by having a groove on a terminal of the plug member and a co-operating spring in the corresponding socket.

Cables in accordance with the invention may be factory made in predetermined but various lengths, to suit various standard length requirements, and may be coupled together end-to-end in modular fashion to produce other lengths. Furthermore, by applying the plug and socket members to cable lengths under controlled conditions rather than in a possibily hostile environment, the chance of error during assembly and the chance of error in carrying out a cable splice or fitment of a junction box is reduced.

The invention finds particular, though not exclusive application to electric cables of the type having one or more, for example two, conductors embedded in conductive polymeric material. The conductive polymeric material may be PTC (positive temperature coefficient) material and thus the cable may be a self-regulating heater, as mentioned above for example. Alternatively, the cable may be a sensor cable, for example as sold by Raychem under its trade name TRACETEK.

Embodiments of cable, and cable interconnections will now be described, by way of example, with reference to the

accompanying drawings, in which:-

Figures 1 and 2 are a schematic plan view and a side elevation respectively of a heater cable;

Figure 3 is a plan view of the interconnection of two cables each of which is as shown in Figures 1 and 2; and

Figures 4 and 5 are a schematic plan and elevation respectively of a splice member for use with the cable of Figures 1 and 2.

Referring to Figures 1 and 2, a self regulating AUTOTRACE heating cable 2, available from RAYCHEM, of a nominal ten metre length has a pair of metal conductors 4 extending therealong embedded in PTC conductive polymeric material (not shown) and surrounded by an outer polymeric insulating jacket 6. The conductors 4 are exposed at each end of the cable 2.

A plug 8 having an insulating body is moulded on to one end of the cable 2, and a pair of conductive terminals 10, connected to respective ones of the conductors 4, project therefrom.

A termination 12 having an insulating body is moulded on to the other end of the cable 2, and a pair of conductive sockets 14, connected to respective ones of the conductors 4, are enclosed therewithin. The sockets 14 are filled with gel, and a pair of caps 16 seal in the gel. The sockets 14 are configured so as to receive terminals 10 of a corresponding cable 2 as a tight push fit therein.

Figure 3 shows the interconnection between the terminals 10 of plug 8 of one cable 2 and the sockets 14, after removal of the end caps 16, of a corresponding cable 2, with some of the gel 18 having exuded from the sockets 14.

The plug 8 and termination 12 are arranged to interlock in a snap fit so that they cannot subsequently be pulled apart. To this end, the termination 12 contains a spring (not shown) that is secured to and that extends around its outer surface, and the plug 8 has a co-operating annular groove on its outer surface. On interengagement of the plug 8 and termination 12 as shown in Figure 3, the spring engages the groove and locks therein.

Referring to Figures 4 and 5, a connector 20 for forming a T-splice between three cables 2 (not shown in these Figures) has a generally cube-shaped insulating body, from one face of which projects a pair of conductive terminals 22. Two pairs 24,26 of conductive sockets are embedded within the insulating body, one socket of each pair being electrically connected therewithin to a respective one of the terminals 22. The sockets 24 extend towards a face of the connector 20 opposite to that from which the terminals 22 project, and the sockets 26 extend towards an orthogonal face. Each of the sockets is sealed with gel and closed by an end cap 28.

In use, the end caps 28 are cut off, and the pins 10 of plugs 8 of two cables 2 inserted into respective ones of the pairs 24,26 of sockets, and the terminals 22 are inserted into sockets 14 of a termination 12 of a further cable 2. Thus, a T-splice is formed with two of the cables being aligned and the third extending orthogonally thereto.

CLAIMS

1. An electric cable comprising: at least one elongate conductor enclosed within electrically insulating material; a plug member comprising an insulating body environmentally sealed on to one end of the cable and having at least one conductive terminal electrically connected to the conductor or to respective ones of the conductors, and projecting from the insulating body; and a one-piece socket member environmentally sealed on to the other end of the cable and having at least one conductive socket, the or each socket being arranged on removal of part of the socket member to receive therein the terminal, or respective ones of the terminals, of a plug member corresponding to said plug member.

2. A cable according to claim 1, wherein the seal comprises an insulated cap that is sealed on to the other end of the cable so as to enclose the or each socket.

3. A cable according to claim 1 or 2, wherein the seal comprises a quantity of sealant material.

4. A cable according to claim 3, wherein the sealant material comprises a gel.

5. A cable according to any preceding claim, wherein the socket member comprises two or more sockets in electrical connection with the or each conductor of the cable whereby two or more corresponding plug members are electrically connectable to the socket member.

6. A cable according to any preceding claim, wherein the socket member and the plug member are arranged such that on engagement of the socket member with the corresponding plug member, the latter members interlock.

7. A cable according to any preceding claim wherein the or each conductor is embedded within a conductive polymeric material.

8. A cable according to claim 7, comprising a PTC heating cable.

9. A cable according to any of claims 1 to 6, comprising a sensor cable.

10. A splice member suitable for use in connecting together two or more cables, each of which is in accordance with any of claims 1 to 9, the splice member comprising an insulating body member, at least one conductive terminal projecting therefrom, and at least one, and preferably two or more, sockets electrically connected with the terminal or with respective ones of the terminals, each of the sockets being environmentally sealed.

11. A method of interconnecting two electric cables, each of which comprises at least one elongate conductor enclosed within electrically insulating material, wherein a first of the cables has a plug member comprising an insulating body environmentally sealed on to the end thereof, the plug member having at least one conductive terminal electrically connected to the conductor, or to respective ones of the conductors, and projecting from the insulating body, wherein a second of the cables has a socket member sealed on to one end thereof, the socket member having at least one conductive socket that is environmentally sealed, and wherein the environmental sealing of the socket is disturbed and the plug member is engaged with the socket member so that the or each terminal engages with the or a respective socket to effect interconnection of the conductors of the two cables.

12. A method according to claim 11, wherein the seal is provided by a termination, and is disturbed by removing at least part thereof.

13. A method according to claim 11 or 12, wherein the seal comprises a quantity of sealant material, and is disturbed by inserting the or each terminal therethrough.

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